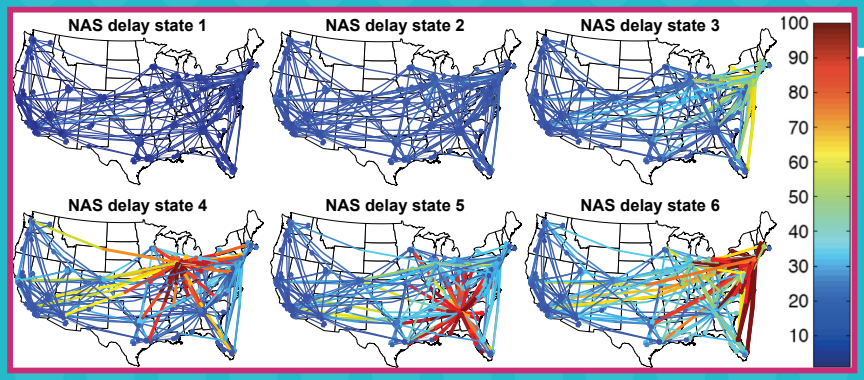
CS Bits and Bytes
Highlighting Innovative Computer Science Research

Air Traffic Control



Characteristic delay states of the National Airspace System, identified through clustering. These delay states have been shown to help predict flight delays in the air traffic network.
Image credit: Hamsa Balakrishnan, MIT

NOV 10, 2015 • VOLUME 04 • ISSUE 02

> There are many cases where we can improve the performance of systems that billions of people interact with. And it all begins with fundamental research to develop better algorithms that incorporate data from the real workld.
>
> -- Hamsa Balakrishnan


Hamsa Balakrishnan

Algorithms to Reduce Air Traffic Congestion

Have you been on a plane that pulls away from the gate and sits for what seems like forever before taking off? Not only is it inconvenient, but it also burns excess fuel and costs money.

Researchers are working to help reduce the wait time that planes spend taxiing on the runway through a combination of new embedded technologies and better models of air traffic control systems.

A team led by Hamsa Balakrishnan at the Massachusetts Institute of Technology (MIT) analyzed historical data to develop realistic models of how airports and the people who run them operate under a range of conditions. The models focused on algorithms (a set of step-by-step instructions used to solve a problem) to optimize pushback, or the rate at which planes should leave their gates.

After the models were developed, the team ran simulations, or virtual experiments, to ensure their validity of the algorithms. Then, the researchers took their models to the Federal Aviation Administration (FAA) and major air carriers to test under real airport conditions. This prototyping showed that they could reduce taxiing time, without adding any delays to the system.

The fundamental research that underlies these models and algorithms extends beyond air traffic control to other areas of research. Related algorithms are being used to study energy usage in a home and help improve the queuing system of Uber, the popular ridesharing service.

Who does this stuff?

Hamsa Balakrishnan is a professor of aeronautics and astronautics at the Massachusetts Institute of Technology (MIT). Balakrishnan began her career as an aerospace engineer. Over time, her research migrated from the nuts-and-bolts of how aircraft fly to the details of how air traffic systems operate overall. Today, she studies air traffic control and management and works to come up with the analytic tools and algorithms required to keep flights safe and runways moving efficiently.

CS Bits and Bytes
Highlighting Innovative Computer Science Research

ACTIVITY

An algorithm is a set of ste-by-step instructions used to solve a problem. As with many problems, there is not only one solution, and you must make decisions about tradeoffs such as time, simplicitiy, or cost. The following activity, adapted from Curriki.org, will help to provide an introduction to the concept of algorithms.

1. Make a list of the different transportations options that you have to reach home from your current location. You might walk, take a bus or taxi, or drive.

2. Develop a simple algothim for each (e.g., Step 1. Go to the bus stop. Step 2. Board the bus. Step 3. Get off the bus at the closest stop near your home. Step 4. Walk to your home.).

3. If you were running late to meet someone at your home, which option/algorithm would be optimal? If you suddenly realized that you forgot your wallet, which option would you select and why?

4. As you can see, under different circumstances, one option/algothm may be optimal over another. In Dr. Balakrishnan's work described here, what was the factor used to optimize the algorithm she and her team developed?

Learn More

Designing tomorrow's air traffic control systems

http://go.usa.gov/cr3Qm

MIT's Hamsa Balakrishnan

http://www.mit.edu/~hamsa/research.html

About

CS Bits & Bytes is a bi-weekly newsletter highlighting innovative computer science research. It is our hope that you will use CS Bits & Bytes to engage in the multi-faceted world of computer science to become not just a use, but also a creator of technolgoy. Please visit our website at: www.nsf.gov/cise/csbytes.

Aircraft queues on the surface of New York's LaGuardia airport, as seen from surface surveillance data. The green icons depict departures, and the red ones denote arrivals. Note the long queue of departures waiting to takeoff from the runway. Visualization using Google Earth ™.
Image credit: Hamsa Balakrishnan, MIT

National Science Foundation
Computer & Information Science & Engineering Directorate
4201 Wilson Blvd, Suite 1105
Arlington, VA 22230

CS Bits & Bytes
http://www.nsf.gov/cise/csbytes
Please direct all inquiries to:
CSBitsandBytes@nsf.gov